LOWER COLUMBIA RIVER

Geographic Response Plan

(LCR-GRP)

NON-FLOATING OILS RESPONSE OPTIONS AND CONSIDERATIONS

Information about potential response options in the planning area

November 2020

INTRODUCTION

This chapter is purposely broad in scope and should not be considered comprehensive. This material is intended to provide general information during the first phase of a spill response. During an actual incident, additional information about the spill scenario, impacted areas, weathering properties of the oil, and sunken oil survey methods and recovery options will be available from private organizations or federal, state, tribal, and local government agencies.

The information provided in this chapter may be useful in:

- Assisting the Environmental Unit (EU) in identifying locations where non-floating oil may sink or collect during a spill response, and in identifying survey and response strategies for sunken oil.
- Providing non-floating oil "context" to responders, clean-up workers, and others during the initial phase of a spill response in the GRP area.
- Briefing responders and incident command staff that may be unfamiliar with environmental conditions related to non-floating oils in the GRP area.
- Providing background information for personnel involved in media presentations and public outreach during a spill incident.

BACKGROUND

Traditional response and preparedness methods focus on containing and recovering floating oil through the use of containment booms and on-water skimmers. However, not all oils float. Oils that sink or become suspended in the water column cannot be successfully recovered with floating oil techniques. Priority should be given to preventing, minimizing, and containing heavy oil and potentially non-floating oil spills at their source. Additionally, since many oils may initially float, rapid and aggressive surface oil recovery efforts should be pursued in the early phase of a spill.

The following general definitions from the American Petroleum Institute (API) characterize oil behavior when spilled in the environment (API 2016):

- Floating oil – spilled oil that remains on the surface of the water.
- Submerged oil – spilled oil in the water column, below the water surface, including oil that is in temporary suspension due to turbulence. Submerged oil may refloat or sink in the absence of turbulence.
- Sunken oil – spilled oil that is on the bottom of the water body.
- Non- floating – can describe oil that becomes submerged in the water column or sinks to the bottom.

Some oils may float, submerge, and sink in a single spill and oil that has sunk to the bottom can become re-suspended and spread further by currents (API 2016).

PROPERTIES OF OIL AS NON-FLOATING INDICATORS

Crude oil is made up of hydrocarbons ranging from volatile, light materials (such as propane and benzene) to more complex heavy compounds (such as bitumen, resins, and waxes). Light crudes like Bakken are made of mostly light and medium weight hydrocarbons that may evaporate quickly or dissolve in the water column; after it is spilled to the environment and subjected to natural physical weathering, small amounts of any remaining heavy ends could be at risk of sinking. Heavy crudes like diluted bitumen are composed mostly of medium and heavy compounds with the potential to only minimally evaporate into air or dissolve into water, and may readily agglomerate and sink or adhere to soil and sediment, particularly after its lighter portions have evaporated. Refined petroleum products (such as gasoline or diesel) are made of specific ranges of hydrocarbons. An oil's viscosity, density, and other inherent properties of crude, refined oil, and waste petroleum products are strong determinants of the potential for the oil to sink (API 2016).

A review of the operations within Washington State identified the following oil types transferred by vessel, pipeline, and rail as having potential non-floating properties based on the oil-to-water density and waterbody characteristics:

- All crude oils
- Heavy fuel oils, including those transferred to vessels in marine waters
- Vacuum gas oil
- Used and waste oils
- Asphalt and asphalt products
- Decant oil

For more information about the bulk oil facilities that operate within this planning area, and the volume of oil transfers over water, please refer to the Ecology Spills Map.

OIL WEATHERING DETAILS

Physical weathering describes how the oil changes when spilled into the environment. Weathering processes may include evaporation, biodegradation, natural dispersion, adhesion to materials, interaction with mineral fines, emulsification, dissolution, photo-oxidation, and sedimentation. Certain types of physical weathering may lead to submergence or sinking of some portion of the oil spilled into the environment (uSCAT Manual).

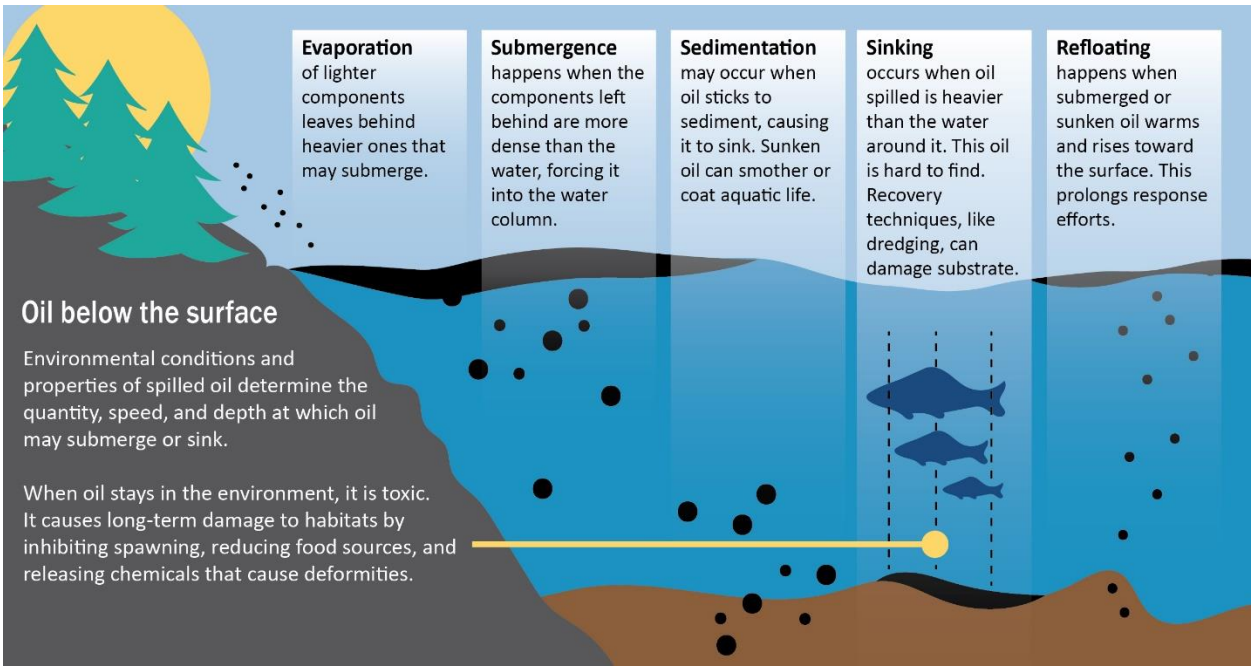

Figure 1: Behaviors of non-floating oil when spilled into the environment. (Ecology, 2018)

NON-FLOATING OIL RISK ASSESSMENT

This section includes a description of locations within the planning area that are at higher risk from non-floating oil spills. The locations identified as higher risk represent areas where sunken oil may collect, and may be areas of focus for surveys after a spill of heavy oil, or after observations of oil weathering and sinking during a spill. The risk assessment is not a guarantee that oil will collect in these areas or that these conditions will definitely cause oil to sink that is otherwise floating. Analysis of non-floating oil risk factors included identification of the following conditions:

- **Water density**: If spilled oil is denser than the receiving water, it sinks. Heavy oils spilled to less dense water or fresh water may result in the oil sinking more quickly. Density is affected by both salinity and temperature.
    - **Salinity**: Oil is more likely to sink in freshwater, but may refloat in salt water. Oil in a river may travel along the river bottom until it reaches the ocean or Puget Sound, where it may refloat. Oil in a marine zone may start to sink when it enters an estuary or other low-saline area.
    - **Temperature**: Temperature affects the density of an oil and slows oil weathering; higher temperatures causes lower oil densities and faster weathering (evaporation). Lower temperatures increase density and reduce evaporation rates. Oil is more likely to sink in cold water. Aside from seasonal variation, some locations may be colder or warmer than surrounding areas due to water depth, shade from landforms, or influx from other waterbodies. During a spill, oil may sink and refloat over the course of each day as the surface temperature changes.

- **Water turbidity**: Turbulence can result in increased sediment loads in the water column that, if entrained with spilled oil, may increase the oil's density and cause it to submerge or sink. High turbidity in the waterway may result in the formation of oil-mineral aggregates, which may result in sedimentation and sinking of the oil.
- **Waterway currents**: Slower currents may allow submerged oil to sink and remain in place, whereas fast currents will churn oil into a suspension in the water column.
- **Substrate composition:** Mud is found in low-energy areas, where sunken oil may settle, collect, and remain in place. Sand indicates a medium-energy area, and gravel indicates high-energy where sunken oil is unlikely to collect or remain in place.
- **Shoreline composition**: Sediment mixing happens when oil strands on a shore and mixes with sandy sediments, or when wave action mixes sediments with oil in the water column. Wave interaction with sandy beaches may result in the formation of tar balls and sinking oil. Washington Department of Natural Resources (DNR) ShoreZone data identifies shorelines with sand beaches and their degree of wave exposure.
- **Sinks**: Sinks were identified using bathymetry data. They do not reflect the deepest spots within the entire planning area; if oil is in the vicinity, it may collect in the sinks.

The locations highlighted in the following map and table were selected because they have a combination of these risk factors. An interactive map showing the combined risk score is also available here. A detailed identification of the species and habitats found in subtidal and nearshore waters throughout the planning area are incorporated into the Resources at Risk section of this GRP.

Early Assessment Guidance

Initial sinking oil risk assessments conducted during the early hours of a spill should focus on the oil properties. Ongoing observations and data collection support updates of the risk assessment, based on how the oil weathers and behaves in the environment. The NOAA ADIOS weathering model may be used to help predict how the oil product will change over time. If these models and real time observations indicate that the oil is sinking, a variety of surveying or recovery methods may be selected to confirm sunken oil and locate the areas where it is collecting.

Subsurface Survey and Response Considerations

Survey and recovery methods must be selected with care using the environmental conditions of the water and sensitivity of resources in the area, and must ensure more harm is not done when recovering the oil. See Table 3-2 in the API Technical Report on Sunken Oil Detection and Recovery to learn about how survey methods are chosen. Once these surveys have confirmed the location, amount, and characteristics of sunken oil, a customized plan to remove the sunken oil can select the most effective and non-damaging methods for the environment. The API report and the USCAT manual both detail a variety of methods to survey and recover sunken oil in a range of environments.

Along with spill-specific modeling, the table below can help the Environmental Unit and Operations Section select effective survey and recovery methods for these high-risk areas. In addition, real-time information considered during a spill response may include spill location, oil type and characteristics, weather, tides, currents, trajectory, seasonal species data, and overflights or other real-time verification methods.

- **Maximum depth in feet:** Some survey and recovery methods are only effective within certain depth ranges, due to pressure, visibility, and distance from the operating vessel.
- **Seafloor resources:** Some survey and recovery methods could damage shipwrecks, cultural sites, shellfish beds, eelgrass beds, or spawning grounds.
- **Hazards and safety concerns:** Divers and the environment may be harmed by survey and recovery methods that damage contaminated sediments from Superfund sites or sewage spills, as indicated by closed shellfish areas. Towed equipment could snag on underwater pipelines and damage the pipeline or the survey boat. Recreational dive sites should be evacuated before surveying and cleanup is conducted, and may include seafloor structures that could snag equipment.

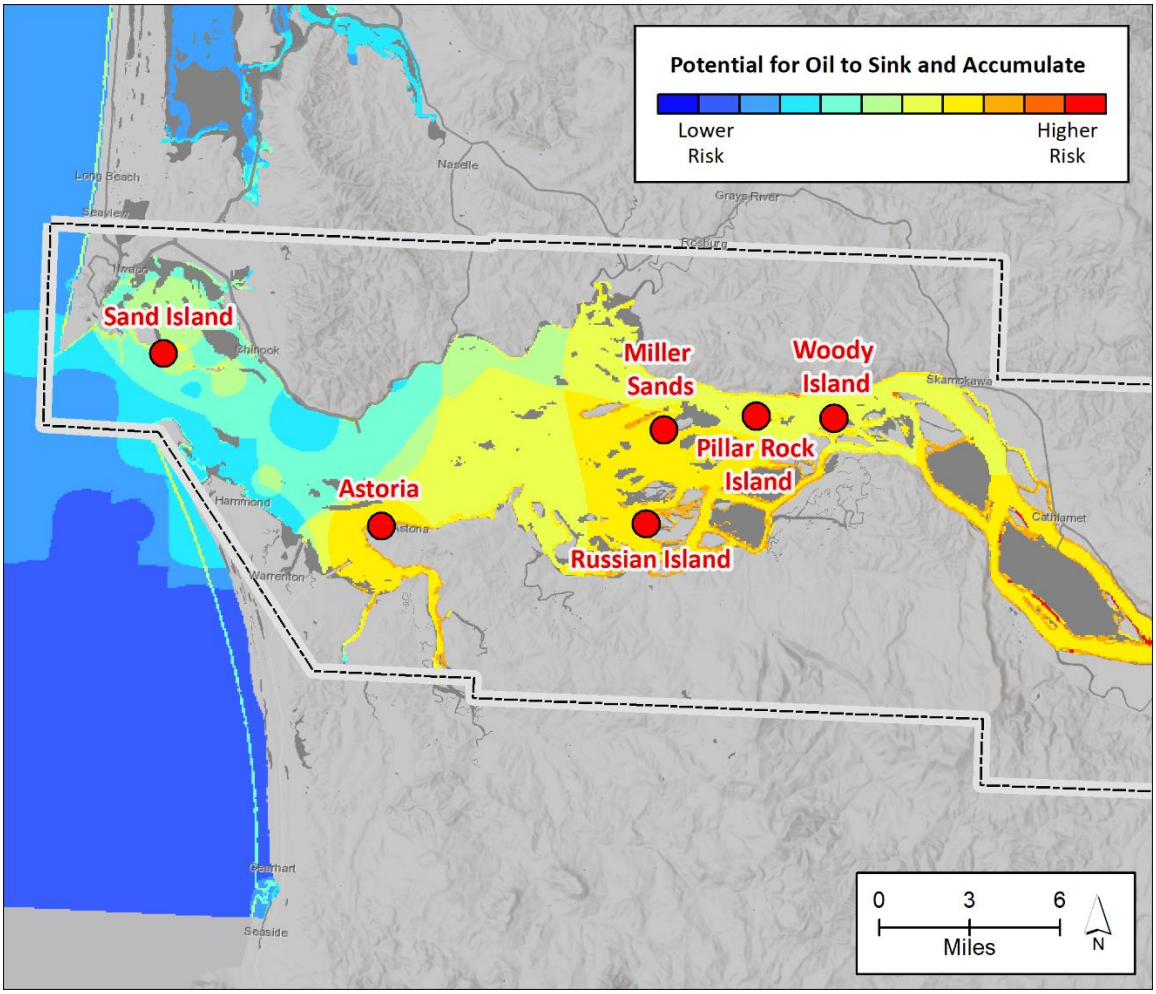

Figure 2: Lower Columbia River higher risk areas for non-floating oil impacts.

Conditions and Considerations For Non-Floating Oil

	Location			
	Sand Island	Astoria	Russian Island	Millar Sands, Woody Island, Pillar Rock
Environmental conditions that impact oil weathering, sinking, or accumulating on the seafloor				
Water Density				
Turbidity				
Currents				
Substrate				
Exposed Sandy Shorelines				
Sinks				
Considerations that support the identification of sunken oil survey or recovery methods				
Maximum Depth (feet)	100	390	300	250
Specific Area of Concern (see Resources at Risk section)				
Seafloor resources present in the area				
Heritage Sites or Shipwrecks				
Seagrass and Kelp Beds				
Open Public Shellfish Harvesting				
Open Commercial Shellfish Harvesting				
Spawning Area				
Safety hazards present in the area				
Closed Shellfish Harvesting (Possible Contaminants)				
Contaminated Sediments / Superfund Site				
Recreational Diving Area				
Pipelines, Cables, Safety Hazards				

= Higher Risk = Medium Risk = Lower Risk

= Present = Absent